



## Segmentation of Connective Tissue in Meat from Microtomography Using a Grating Interferometer

Einarsdottir, Hildur; Ersbøll, Bjarne Kjær; Larsen, Rasmus

*Publication date:*  
2014

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Einarsdottir, H., Ersbøll, B. K., & Larsen, R. (2014). *Segmentation of Connective Tissue in Meat from Microtomography Using a Grating Interferometer*. Abstract from 2nd International Workshop on X-ray and Neutron Phase Imaging with Gratings (XNPIG 2014), Garmisch-Partenkirchen, Germany.

---

### General rights

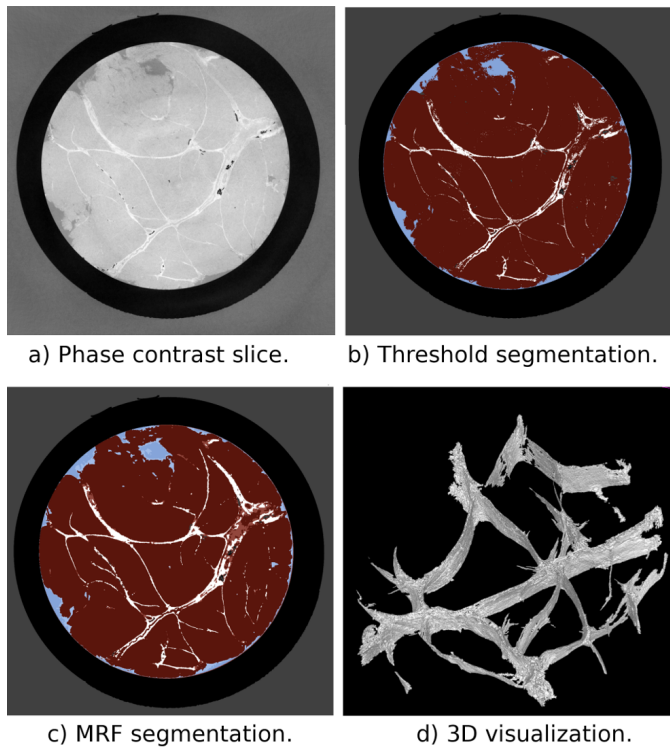
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

# Segmentation of Connective Tissue in Meat from Microtomography Using a Grating Interferometer

Hildur Einarsson<sup>1</sup>, Bjarne K. Ersbøll<sup>1</sup> and Rasmus Larsen<sup>1</sup>



**Figure:** In a) a single slice from the phase contrast tomogram is shown, b) illustrates the results from a conventional threshold segmentation, c) shows the results from the anisotropic MRF segmentation and d) shows a 3D visualization of part of the segmented connective tissue.

It has been demonstrated that phase contrast imaging provides superior contrast of soft tissues in biological material over typical absorption tomography [1-2]. In meat science, this imaging modality can provide valuable information of the effects of heat treatment on muscle tissue. Although microtomography provides high resolution, the thin structures of the connective tissues are difficult to segment. This is mainly due to partial object voxels, image noise and artifacts. The segmentation of connective tissue is important for quantitative analysis purposes. Factors such as the surface area, relative volume and the statistics of the electron density of the connective tissue could prove useful for understanding the structural changes occurring in the meat sample due to heat treatment.

In this study a two step segmentation algorithm was implemented in order to segment connective tissue from phase contrast microtomograms obtained by a grating-interferometer. This segmentation has previously been demonstrated for the segmentation of the optic nerve head from microscopic images of stained slices [3]. The first step is to model the data as a mixture of Gaussians using an expectation-maximization (EM) algorithm [4]. This iterative process finds the maximum likelihood of parameters where the model depends on unobserved latent variables. The spatial information of the data is next incorporated into the segmentation process by modeling the data as a Markov random field (MRF) [5]. It models the a priori probability of neighborhood dependencies, and the field can either be isotropic or anisotropic. For the segmentation of connective tissue, the local information of the structure orientation and coherence is extracted to steer the smoothing (anisotropy) of the final segmentation. The results show that the segmentation provides a superior classification of connective tissue over conventional threshold segmentation. Additionally modeling the data as a mixture of Gaussians made it possible to segment the connective tissue into two separate classes. The segmentation results provide the means for further analysis of the structural changes in the meat due to heat treatment.

## REFERENCES

- [1] Jensen, T. H., Böttiger, A., Bech, M., Zanette, I., Weitkamp, T., Rutishauser, S., ... & Pfeiffer, F. (2011). X-ray phase-contrast tomography of porcine fat and rind. *Meat Science*, 88(3), 379-383.
- [2] Pfeiffer, F., Bunk, O., David, C., Bech, M., Le Duc, G., Bravin, A., & Cloetens, P. (2007). High-resolution brain tumor visualization using three-dimensional x-ray phase contrast tomography. *Physics in medicine and biology*, 52(23), 6923.
- [3] Grau, V., Downs, J. C., & Burgoyne, C. F. (2006). Segmentation of trabeculated structures using an anisotropic Markov random field: application to the study of the optic nerve head in glaucoma. *Medical Imaging, IEEE Transactions on*, 25(3), 245-255.
- [4] Dempster, A. P., Laird, N. M., & Rubin, D. B. (1977). Maximum likelihood from incomplete data via the EM algorithm. *Journal of the Royal Statistical Society. Series B (Methodological)*, 1-38.
- [5] Li, S. Z. (2003). Modeling image analysis problems using Markov random fields. *Handbook of Statistics (S0073-6333)*, 21(13), 473-513.

<sup>1</sup> Department of Applied Mathematics and Computer Science, Technical University of Denmark, Denmark  
✉ Hildur Einarsson, hildr@dtu.dk